

## University of Houston Master Specification

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### SECTION 23 7420 - CUSTOM AIR HANDLING UNITS

Revise this Section by deleting and inserting text to meet Project-specific requirements.

- 3 Maintain Section format, including the UH master spec designation and version date in the center columns of the header and footer. Complete the header and footer with Project information.

This Section uses the term "Engineer." Change this term to match that used to identify the design professional as defined in the General and Supplementary Conditions.

Verify that Section titles referenced in this Section are correct for this Project's Specifications; Section titles may have changed.

Delete hidden text after this Section has been edited for the Project.

#### PART 1 - GENERAL

##### 1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
- B. The Contractor's attention is specifically directed, but not limited, to the following documents for additional requirements:
  - 1. The current version of the *Uniform General Conditions for Construction Contracts*, State of Texas, available on the web site of the Texas Facilities Commission.
  - 2. The University of Houston's *Supplemental General Conditions and Special Conditions for Construction*.

##### 1.2 DESCRIPTION OF WORK

- A. Section Includes: Provide field or factory-assembled air handling units and components as shown, scheduled, and indicated on the Drawings.
- B. Types: Air-handling units required include:

**[Edit to suit project]**

- 1. Single-zone constant volume indoor air handling units.
- 2. Single-zone variable air volume indoor OA pretreat air handling units.
- 3. Single-zone variable air volume indoor air handling units.
- 4. Double duct indoor air handling units.

##### 1.3 QUALITY ASSURANCE

- A. Coil Certification: Coils shall be designed and rated in accordance with AHRI Standard 410.
- B. AMCA Seal: Fans shall be designed and rated in accordance with AMCA Standards and shall bear the AMCA Seal for air and sound.

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- C. **[Dampers: Dampers shall be factory-certified in accordance with AMCA Standard 500D.]**  
Factory-testing for vibration, acoustical performance and unit run testing shall be witnessed by the Owner's Representative. The Contractor shall pay for air fare, accommodations, and similar expenses so that two Owner's Representatives can witness the test.

### 1.4 ACTION SUBMITTALS

- A. Submittals shall include, but not be limited to, the following:
1. Certified drawings showing overall dimensions of complete assembly, weights, support requirements, sizes, location of connections, accessories, and parts list.
  2. Cut sheets on all air handling equipment, clearly marked to show sizes, configuration, construction, features, accessories and other pertinent information.
  3. Curves showing fan performance and system operating point plotted on curves. Data to substantiate that fan can operate in a stable range with a static pressure ½ inch above that schedule, and that the fan motor is sized accordingly.
  4. Coil performance selection data showing all criteria identified on equipment schedule. Certify the coils will meet performance criteria on equipment schedules.
  5. Bearing sizing calculations for each similar size and type of unit. Fan bearing calculations shall be based on fan at maximum operating conditions.
  6. Complete information on the Variable Air Volume modulation method to be furnished. Required torque for all motor-operated dampers information on shaft sizes and location in unit and amount of space available for motor operators.
  7. Performance certifications based on applicable AHRI Standards and prototype unit test reports.
  8. Prototype sound power levels for each size and type of air handling unit at operation conditions specified. Sound levels shall be in all eight octave bands for: discharge off unit, inlet to unit, and radiated noise through fan section casing. Proposed test mockup layout and testing procedure for unit sound level acceptance testing.
  9. Detailed shop drawings showing all dimensional data, including, but not limited to, gauges of sheet metal, panel reinforcing, size and weight per linear foot of structural base members, floor reinforcing, base reinforcing at internal equipment supports, construction details, damper information, filter frames, etc. Information shall be complete in all respects necessary for Architect/Engineer to evaluate the complete construction of the unit.  
Performance certifications based on applicable AHRI Standards and prototype unit test reports.
  10. Product warranties and guarantees.
  11. Wiring diagrams.
  12. Written instructions for installation including assembly where not factory-assembled.
  13. Motor data as required in Section 23 0400 "Motors and Controllers."
  14. Additional information as specified in Section 23 0100 "Mechanical General Provisions".

### 1.5 MAINTENANCE MATERIALS SUBMITTAL

- A. Provide **[one]** **[Insert number]** additional sets of specified filters for each unit, packaged for storage after each unit has been tested and operated for final acceptance by Owner. Tag products to identify associated unit.

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### 1.6 PRODUCT DELIVERY, STORAGE AND HANDLING

- A. Deliver air-handling units in factory-fabricated water-resistant wrapping.
- B. Handle air handling units carefully to avoid damage to material components, enclosure, and finish.
- C. Store air handling units in a clean, dry space and protect from the weather.

### 1.7 WARRANTY

- A. Warranty: The entire air-handling unit(s) shall have a minimum **[one]** **[Insert duration]** year warranty from date of **[Substantial Completion]** **[Insert start date]**.

## PART 2 - PRODUCTS

### 2.0 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products produced by one of the following:

[\[Edit list of mfgs. to suit project\]](#)

- 1. ClimateCraft.
- 2. Energy Labs.
- 3. Engineered Air.
- 4. Haakon.
- 5. Huntair
- 6. Temtrol.

### 2.1 PERFORMANCE

- A. Casing Deflection: **[L/240]** **[Insert deflection]** when tested at a pressure of **[8 inches w.c.]** **[Insert pressure]**.
- B. Casing Leakage: **[0.5 percent]** of design airflow when tested at a pressure of **[8 inches w.c.]** **[Insert pressure]**.
- C. Casing Thermal Requirements: Minimum R-value **[12]** **[Insert value]**.

### 2.2 GENERAL

- A. Draw-thru Type Air-Handling Units: Provide draw-thru type air handling units complete with sound attenuating housing, plug fan section, adjustable blower drive for balancing and fixed drive for permanent installation with motor mounted on resilient base, V-belt drive with guard, fan intake plenum, access sections, pre-filter section, final filter air filter sections, cooling coil section, condensate drain pan, **[heating coil section,]** **[preheat and reheat coil sections,]** outside air

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damper (outside air units only) and other attached sections indicated on Drawings, specified herein or required to accomplish the specified control sequences.

- B. Double Duct Air-Handling Units: Provide blow-thru type air handling units complete with sound attenuating housing, fan section, adjustable blower drive for balancing and fixed blower drive for permanent installation with motor mounted on resilient base, V-belt drive with guard, air filter section, cooling coil section, **[heating coil section,]** air distribution grid, **[bypass section with equalizing baffles,]** condensate drain pan, and other attached sections indicated on the Drawings, specified herein or required to accomplish the specified control sequences.
- C. General Construction: Fans, sheaves, motors, and belts shall be factory-assembled and balanced with the fan section casing. Air-handling unit fans, bearings, and fan sheave shall be vibration balanced to a maximum of 2 mil in all axes and shall be so certified by the manufacturer prior to installation. The manufacturer shall conduct vibration tests on all units after they have been installed in the field. Replace all components that cannot meet these balance and vibration requirements. Unit shall be constructed with the required field splits for rigging, installation and assembly on the jobsite.
- D. Capacity: Unit characteristics, size, type, capacity, and arrangement shall be as scheduled and shown on the Drawings. Unit shall be capable of stable operation at a static pressure 1/2" above that scheduled and the fan motor shall be sized accordingly.
- E. Access: Unit components shall be accessible through access doors. Where components are larger than the access doors or cannot reasonably be removed through an access door, provide removable sections to facilitate component removal. Disassembly of cabinet or cabinet structure is not an acceptable method of component removal.

### 2.3 CASING

- A. General: Casing shall be airtight, of sectionalized, double wall design with suitable gaskets between sections. Materials shall be phosphatized, bonderized or galvanized steel of lock-forming quality. Steel angle framework shall be designed to provide maximum rigidity, prevent pulsation and shall be of the same finish as the casing. Casing shall include fan section and coil sections with drain pan.
- B. **[Interior Perforated Liner (Downstream of Final Filters): Each unit shall be constructed with an interior perforated liner which shall protect the insulation while allowing acoustical absorption. Insulation shall have a continuous covering of Tedlar film under the perforated liner such that there is not any insulation directly exposed to the air stream downstream of final filters. Liner shall be electrically and thermally isolated from galvanized steel to prevent galvanic action of the two dissimilar metals by use of an acrylic/sealant or approved alternative. Perforated liner shall be 0.030 inch thick aluminum.]**
- C. **[Interior Perforated Liner (Except Downstream of Final Filters): Each unit shall be constructed with an interior perforated liner which shall protect the insulation while allowing acoustical absorption. Liner shall be electrically isolated from galvanized steel to prevent galvanic action of**

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**the two dissimilar metal by use of an acrylic adhesive/sealant or approved alternative. Perforated liner shall be 0.030 inch thick aluminum.]**

- D. Finish: Galvanized metal shall not be painted. Phosphatized or bonderized metal shall be finished with rust-inhibiting paint.
- B. Floors: Construct unit floors of aluminum tread plate, minimum 0.10 inch thick, insulated with foam insulation.  
Floor shall be welded to structural base members below with no penetrations through the floor. Welds shall be below the floor and spaced no greater than 6 inches on center.  
  
Minimum 20-gauge galvanized sheet shall enclose the insulation on the bottom of the unit.
- E. Coil Section: All connections, coil headers, and return bends shall be completely enclosed. Coil frames shall not be used as reinforcing for the housing. Construction shall be such that the coils can be removed through access panels without affecting the structural integrity of the casing.
- F. Drain Pan: Provide a rigid and watertight positively sloped IAQ drain pan with pipe drain connection under the complete coil section on horizontal units and under the fan and coil section on vertical units. Drain pan shall be of the double pan insulated type with a [304] [316L] stainless steel inner pan and a galvanized or painted steel outer pan. Insulation shall be 1 inch thick, high density fiberglass cemented and vapor sealed between the inner and outer pan or 1 inch thick foamed in place, closed cell insulation. A [304] [316L] stainless steel intermediate condensate drip pan shall be provided on all coils over 48 inches high. Intermediate drain pans shall be factory-piped to main condensate drain pan. Drain pans shall be positively sloped internally to external drain connections as shown on the Drawings.
- G. Access Doors: Provide windowed access doors in all sections of AHU for walk-in access to internal parts. Locate door to allow inspection regardless of mounting arrangement. Fan section access doors shall be equipped with a factory-installed and wired blower motor / access kill switch.
1. Door size must be at least [24][Insert width] inches wide and full panel height up to 72-inches tall. For units above 72 inches tall, provide 72-inch high doors.
  2. Access door construction shall equal or exceed the quality of air-handler casing materials.
  3. Doors shall include a minimum 8-inch by 8-inch double glazed view window, capable of withstanding the total developed pressure of the unit.
  4. Doors shall be hinged using either heavy-duty adjustable stainless-steel butt hinges or a continuous adjustable stainless steel piano hinge, extending along the entire edge of the door, except for a maximum of 2-inches at each end. If butt hinges are used, provide two (2) per door for up to 36-inch high doors and three (3) per door for taller doors. Provide minimum of two (2) latches on doors taller than 18 inches and three (3) latches on doors over 36 inches tall. Latches shall be Ventlok 310, heavy-duty latch or approved alternative.
  5. Access doors shall open against positive air pressure, unless they are the outer doors of the air lock entrances or approved by the Owner in writing.

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### H. **Insulation:**

1. Casings for double wall units shall be thermally and acoustically insulated.
2. Insulation shall be minimum **[two][three][four]** inches thick.,
3. Insulation density shall be **[1-1/2] [3]** pound minimum.
4. Insulation R-value shall not be less than **[R-12][Insert Requirements]** fiberglass.
5. All exposed parts such as angles, braces, and similar items in contact with exterior surfaces shall be covered with insulation to prevent condensation on the exterior casing.
6. Insulation shall be installed to allow panel removal without disturbing insulation. Where condensation may occur, the exterior wall shall be aluminum or stainless steel.
7. Insulation shall be installed between the panel walls to prevent air flow over the insulation and to allow removal without disturbing the insulation.
8. All insulation shall have a composite fire and smoke hazard rating complying with NFPA 90A.
9. When exposed to the airstream the combustion rating of insulation and adhesives shall not exceed a flame spread ration of 25 and a smoke development rating of 50 when tested in according to ASTM E84 and NFPA 255.

### 2.4 COILS

- A. General: Coils shall have capacities and ratings as scheduled and shall be rated by the manufacturers in accordance with AHRI Standard 410. Non-certified coils will not be acceptable.
- B. Core Construction: Coils shall be constructed of copper tubes with **[aluminum] [or] [copper]** plate fins with a maximum of **[8] [12] [ ]** fins per inch and shall be arranged for counter flow operation. Fins shall be bonded to the tubes by means of mechanical expansion of the tubes. Supply and return connections shall be on the same end of the coil. Tubes shall be 1/2 inch or 5/8 inch OD spaced approximately 1-1/2 inch apart, with a minimum wall thickness of **[0.020] [0.024] [0.035]** inch. Flat fins shall have a minimum wall thickness of 0.0075 inch. Tapered smooth fins shall taper in thickness from 0.01 inch at point of contact to 0.005 inch at the periphery.
- C. Headers: Coil headers and connections shall be constructed of copper or admiralty brass. Joints between core tubing and headers shall be of a recessed swage design to provide a large mating area for brazing. Supply and return connections shall be terminated NPT threaded connections with wrench flats.
- D. Casings: Coil casings shall be constructed with angle shapes bolted with stainless steel bolts and rigidly supporting the coil assembly. Casing frame members shall extend over the ends and edges of the coil and shall have formed holes for tubes, permitting free expansion and contraction of coil components. Intermediate tube supports shall be provided such that maximum unsupported tube length does not exceed 48 inches. Casings, including all supports and frames, shall be constructed of **[304] [316L]** stainless steel **[for all cooling coils] [and preheat coils] [and] [galvanized steel]** for all **[heating]** coils.
- E. Miscellaneous Requirements:

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1. Minimum tube velocity at design flow rate shall be [3] [Insert velocity] feet per second.
2. Coils installed in series shall have a minimum of [18] [24] [Insert dimension] inches between the faces with provisions for access between the faces for cleaning.
3. Provide internal light for each access, coil and fan section. Light shall be vapor proof with glass globe and guard. Lights shall be prewired to a 120 volt external disconnect switch. 120 volt 15 amp circuit shall be furnished by Division 26.
4. Provide drain and air vent connections, except where the coil header piping is designed to be self-venting. Test coils by air pressure under water at 1-1/2 times the pressure indicated on Drawings. The test pressure shall in no case be less than 250 psig, nor more than 500 psig.

- F. Chilled Water Cooling Coils: Coils shall be a minimum of [minimum] [maximum] of [six] [eight] rows deep or as scheduled. **[Where more rows are required, multiple coils shall be provided.]** Cooling coil capacity, maximum face velocity, and maximum air pressure drop shall be as scheduled. Water velocity in the tubes shall not exceed 5' per second and the water pressure drop through the coil shall not exceed [10] [15] feet, unless lower maximums are scheduled. All cooling coils shall be installed in a vertical position (perpendicular to airflow) to minimize condensate carry over. Coils shall be designed and certified by the manufacturer to operate at the scheduled face velocity plus 10% without moisture carry over.
- G. Hot Water Heating Coils: Coils shall be furnished in the unit where scheduled and shall have a minimum of two rows. Heating coil capacity, maximum face velocity and maximum air pressure drop shall be as scheduled. Coils shall be installed in the bypass or heat position, except in outside air units where the coils shall be in the preheat position. Water velocity in the tubes shall not exceed 5' per second and water pressure drop shall not exceed 10', unless lower maximums are scheduled.
- H. Steam Heating Coils: Coils shall be furnished in the unit where scheduled and shall have a minimum of two rows or as scheduled. Heating coil capacity, maximum face velocity and maximum air pressure drop shall be as scheduled. Coils shall be installed in the heat position, except in outside air units where the coils shall be in pre-heat and reheat positions.
- I. Bypass Deck Baffle: On dual duct units, the coil position on the neutral deck shall have a perforated stainless steel plate installed in lieu of a coil. The plate shall be rigidly mounted and shall have an air pressure drop equal to the cold duct cooling coil.
- J. Coil Access/Pull: All hot water and chilled water coils shall include a removable cover plate mounted in the side of the unit casing for future coil repair/removal. This cover plate shall be located on the side of the unit required for coil removal with the unit installed as shown on the Drawings. The Contractor and unit manufacturer shall coordinate exactly where coil access cover must be located on each unit. All unit submittal drawings must show the access cover. The access cover shall be the same gauge as the unit housing, with gasket or sealant strips and attachment screws provided.

### 2.5 MOTORS/ELECTRICAL

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- A. General: Motors shall be open drip-proof (ODP), 3-phase, 1750 rpm, unless noted or scheduled otherwise. All motors shall be premium efficiency type. Motor selection shall be such that the motor will not overload if the static pressure drops ½ inch below or rises to ½ inch above the specified value. Motors shall be mounted on the coil connection side, unless indicated otherwise and the motor shall be mounted on an adjustable base rigidly supported to the unit. The motor shaft shall accommodate an adjustable pitch motor sheave. Refer to Section 23 0400 "Motors and Controllers" for additional motor requirements. All motors shall be factory mounted and wired to an external junction box.
- B. **[Lighting and Power: Provide a minimum of one vapor-proof LED light fixture in each section/module. Light shall be controlled from a light switch. [Each module will be provided with one convenience outlet, at the inside of each door.] Wiring from lights fixture to switch shall be by unit manufacturer. Unit light fixture [and receptacles] shall be factory-wired to a single external junction box for a single circuit 120 volt, 20A field power connection.]**
- C. Wiring: All wiring shall be 600 volt rated type THHN/THWN stranded copper, enclosed in EMT or flexible metal conduit (maximum 3'). All junction boxes shall be UL-approved and gasketed.

### 2.6 CENTRIFUGAL FANS

- A. Centrifugal Fans: Provide fan types with performance as scheduled on Drawings. All fans shall be statically and dynamically balanced and tested after being installed on properly sized shafts. Fan shafts must not pass through their first critical speed as unit comes up to rated rpm. Fan wheels and scrolls shall be constructed of galvanized steel, all aluminum or fabricated steel protected with two coats of rust-inhibiting paint. Wheels and scrolls of fans used for outside air service shall be coated with two coats of fire resistant epoxy paint. Fan and fan drive shall be internally spring isolated.

Retain either belt or direct drive paragraphs below.

- B. Direct Drives: Fan drive shall be direct. Adjust wheel width and diameter to match motor speed while provide performance scheduled on Drawings. Fasten fan wheel directly to motor shaft using a key and set screw. **[Fan and motor shall comply with Arrangement 4 according to AMCA 99-2404 for single width inlet fans.]**
- C. Belt Drives: Select drives for a minimum belt horsepower capacity of 150% of the motor nameplate horsepower. Provide selection calculations with the drive submittal. The selection calculations shall include the correction factor for arc of contact.
- D. Sheaves: Permanent fan sheaves shall be nonadjustable with removable machined bushings, machined on all contact surfaces. Sheaves with over three grooves shall be dynamically balanced and so designated on each sheave. Fan sheaves with three grooves or less shall be statically balanced and if weights are required, they shall be welded to the sheave. Motor sheave shall be selected for the fan rpm determined by the fan capacity scheduled and shall be adjustable to as close as 10% above and below the rated fan speed. Furnish and install fixed sheaves on units that require more than two belts, after correct speed has been determined with the variable sheave.

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- E. Belts: Provide "V-groove" type suitable for the service intended with the capacities specified. Belts shall be closely matched and tagged for use prior to shipment. Recheck belts for proper match during operation and if necessary, replace with closely matched belt sets.
- F. Shafts: Provide one piece solid design. Fans and shafts shall not pass through their first critical speed as the unit comes up to rated speed.
- G. Shaft Bearings: Provide externally or internally mounted grease lubricated, self-aligning ball or roller bearings on each end of the shaft. Bearings shall have an average L-10 life as defined by AFBMA of 200,000 hours at design operating conditions. All bearings shall be the same size. Internally mounted bearings shall have grease lines extended so as to be readily accessible from the drive side of the unit. In addition, the bearing on the drive end of the shaft shall have grease line extended beyond the belt guard. All grease lines shall terminate in a zerk fitting.
- H. Vibration Isolation: All units shall be internally spring isolated and mounted on pipe columns with ribbed neoprene pads.

### 2.7 FAN ARRAYS

#### A. Fans and Motors:

1. Fan Array: The fan array shall consist of multiple, direct driven, arrangement 4 plenum fans constructed per AMCA requirements for the duty specified, **[Class I, II or III]**. All fans shall be selected to deliver the specified airflow quantity at the specified operating total static pressure and specified motor speed. The fan array shall be selected to operate at a system total static pressure that does not exceed 90% of the specified fan's peak static pressure producing capability at the specified fan/motor speed. Each fan/motor "cube" shall include an 11 gage G-60 galvanized steel motor support plate and structure. The fan intake, inlet funnel, and motor support structure shall be powder coated for corrosion resistance. All motors are standard T-frame pedestal mounted type, (TEFC), selected at the specified operating voltage, speed, and efficiency as specified or as scheduled. Motors shall be rated for inverter duty and include isolated bearing or shaft grounding. To ease the replacement of the assembled fan/motor, the motor must not to exceed the nominal rating of **[10] [15] [Insert HP]** horsepower.
  - a. The fan wall array shall be provided with acoustical silencers to reduce the bare fan noise by a minimum 14 db re 10-12 watts through the eight octave bands with center frequencies of 125, 250, 500, 1000, 2000, 4000 and 8000 hz when compared to same unit without silencers. The silencers shall not increase fan static pressure, nor shall it increase the airway length of the air-handling unit.
  - b. Alternate manufacturers must submit acoustical data for review and approval prior to bid indicating the proposed alternate equipment can meet all specified performance requirements. Proposals submitted which indicate a higher connected fan horsepower than specified or scheduled will not be accepted.
2. Multiple Fan/Motor VFD Control: The fan array shall consist of multiple fan and motor "cubes", spaced in the air way tunnel cross section to provide uniform airflow and velocity profile across the entire airway tunnel section and components contained therein. Each fan cube shall be

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individually wired to a control panel containing power lock-disconnects for individual motor(s) and VFD(s) controlling respective fan motors in the fan array. Each VFD shall be driven by a "master/slave" control scheme and shall be provided with a redundant VFD in the event of a "master" VFD failure. The manufacturer furnishes a spare VFD of the same make and model as the VFD(s) being used to power the array of fans. The VFD(s) and one spare VFD shall be furnished by the AHU manufacturer and shall be protected through a hardwired interlock to allow only one VFD to be energized at a time. Refer to Section 26 2923 "Variable Speed Drives" for requirements. Circuitries for VFD fault /failures, VFD "master" enable, VFD "slave" enable, single fan failure or trip conditions are provided by the manufacturer for connecting with the Owner's building automated system (BAS) for control and monitoring purposes. Connection to the Owner's existing BAS shall be accomplished through hard wire inputs and outputs. Gateway / Interfaces are not allowed. See Fan Array component panel requirements.

3. The fan wall array shall produce a uniform airflow and velocity profile within the airway tunnel of the air-handling unit not to exceed the specified cooling coil and filter bank face velocity when measured 12 inches from the intake side of the fan wall array intake plenum wall and at a distance of 48 inches from the discharge side of the fan wall intake plenum wall.
4. Equip each fan/motor cube with a metal grating fan outlet guard.
5. Each fan array shall also include motor removal rail located on the discharge side of the fan array. The rail shall span the full internal width of the unit.
6. Provide a blanked off panel to isolate the inlet side of one fan/motor assembly that is being removed from the fan array. Any of the fan/motor assemblies in the fan array shall be configured for the blank-off plate.
7. Provide each fan with a factory installed backdraft damper that will prevent air from reverse flow through a non-functioning fan.
8. Each fan array shall include at least one fan assembly with a complete airflow measuring station to indicate airflow in CFM. The flow measuring system shall consist of a flow measuring station with static pressure taps and total pressure tubes located at the fan inlet cone. The flow measuring station shall provide an analog to digital CFM readout using a 4-20ma or 0-10 volt output control signal for use in the BAS. The flow measuring system shall be able to measure airflow within 5 percent of reading on each fan.
9. Manufacturer shall provide one complete spare fan/motor assembly of the fan array with each respective air handler.
10. Plug Fan (PF) SWSI Minimum Class II Fans: Single-width single-inlet arrangement 4 as indicated on the Drawings. Fan wheel with minimum of 12 blades made from extruded aluminum as a hollow airfoil in shape and welded to the center and wheel side plates. The fan Inlet cone shall be made from spun aluminum material.
11. Fans shall be both dynamically and statically balanced. Dynamic fan balancing shall be conducted from 16 Hz to 66Hz to identify and eliminate critical speeds to ensure stable operation through the entire operating range of the fan and drive assembly. Fan shaft shall be turned, ground and polished solid steel rated for maximum speed below critical speed. Fan wheel shall be keyed to the shaft.
12. Fans shall be rated in accordance with AMCA 210 for performance and AMCA 300 for sound.
13. Fan motors shall be premium efficiency and rated for inverter duty per Section 23 0400 "Motors and Controllers."

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### B. Bearings:

1. Antifriction type, either ball or roller, lubricated at the factory and extended lubrication lines where necessary to achieve bearing lubrication or solid silicon nitride (ceramic) bearings.
2. Catalogued type as manufactured by Fafnir, SKF, NTN or Sealmaster; bearings shall be stocked locally.
3. L-10 minimum life of 200,000 hours (direct drive application).
4. Grease fittings for bearings shall be remotely mounted within line of sight of the bearing, where possible. Where line of sight is not feasible, then the fitting shall be mounted with an extended lubrication where it is most easily accessible for service. Stainless steel tubing is used for the remote grease fitting. If the motors are equipped with more efficient solid silicon nitride (ceramic) ball bearings, then lubrication lines are not required.

## 2.8 BELT GUARDS

- A. General: Provide belt guards for all fan drives mounted outside the unit housing. The finish of the guard shall be similar to that of the unit housing. Brace and fasten guards to prevent objectionable vibration. Provide tachometer openings at least 2 inches in diameter for checking fan and motor speeds. Openings shall be centered on shafts to allow checking speed.

## 2.9 FILTERS

- A. General: Provide, as a part of the factory package, filter sections to accommodate the filters of the type and style scheduled and specified at maximum filter face velocity of 500 fpm. Filters shall be as scheduled and specified in Section 23 4000 "Filters and Accessories."

Frame and Support Construction: The filter housing shall be constructed of galvanized steel with support and bracing upstream and downstream to ensure rigid construction.

Filter Racks: Racks shall be provided under this Section for installation on the air handling equipment which it serves. Racks shall be equipped with gaskets and spring type positive sealing fasteners to hold filters in place. Fasteners shall be removable without the use of tools.

### B. Pleated Filters (Pre-filter and Final Filters):

1. General: Provide medium to high efficiency, pleated, disposable type filters where scheduled or shown on the Drawings.
2. UL-listing: Filters shall be listed by Underwriters' Laboratories, Inc. as Class 1.
3. Filter Media: Filter media shall be of the nonwoven cotton fabric type. **[Consult UH FM about the use of polyester filter media and obtained efficiencies of 40% to 60%]** . The filter media shall have an average efficiency of MERV-13 at final filters and MERV 8 at pre-filters.
4. Capacity: Ratings and capacity for pleated filters shall be as follows:
  - a. Two Inch (MERV-8 Efficient Pre-filter): The effective filter media shall be not less than 4.6 square feet of media per 1.0 square foot of filter face area and shall contain not less than 15 pleats per linear foot. Initial resistance of 500 fpm approach velocity shall not exceed 0.28" w.g. Pre-filter shall be installed upstream of the final MERV-13 filter.
  - b. Four Inch (MERV-13 Efficient Final Filter): The effective filter media shall be not less than 7.0 square feet of media per 1.0 square foot of filter face area and shall contain not less than

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11 pleats per linear foot. Initial resistance of 600 fpm approach velocity shall not exceed 0.35" w.g.

5. Media Support Grid: The filter media support shall be a welded wire grid with an effective open area of not less than 96%. The welded wire grid shall be bonded to the filter media to eliminate the possibility of media oscillation and media pull away. The media support grid shall be formed in such a manner that it effects a radial pleat design, allowing total use of filter media.
6. Enclosing Frame: The filter enclosing frame shall be constructed of a rigid, heavy-duty, high wet-strength beverage board, with diagonal support members bonded to the air entering and air exit side of each pleats, to ensure pleat stability. The inside periphery of the enclosing frame shall be bonded to the filter pack, eliminating the possibility of air bypass.
7. Manufacturers: Filters shall be American Air Filter AM-AIR 300X, Farr 30-30 or an approved equal.

### 2.10 DAMPERS

- A. General: Provide dampers capable of being motor operated as required under the applicable temperature control section.
- B. Construction: Dampers shall be galvanized steel and mounted as a single assembly locked securely to a galvanized steel rod that rotates on nylon or teflon bushings. Dampers shall be sectionalized to limit blade length to 50 inches maximum to prevent excessive blade warping. Closed cell neoprene, vinyl polyester or polyurethane blade edging shall be installed to assure tight closure.
- C. Testing: A representative 4 square foot damper sample shall not exceed [6] [Insert value] cfm leakage/square foot at 4 inches wg, when tested by an independent testing laboratory in accordance with AMCA 500D
- D. **[Inlet [Mixing] Dampers: Provide a [mixing box] [damper] section with [ganged] vertical, low leakage, opposed blade dampers positioned across the short dimension of each [outside] air opening. [Each set of dampers in either air inlet shall be offset with respect to the dampers in the other air inlet to provide high efficiency mixing through generation of relative velocity between the merging narrow air streams at different temperatures.]**
- E. **[Face and Bypass Dampers: Provide low leakage coil face and bypass dampers for [heating] [cooling] coils as scheduled.]**

### 2.11 VAV MODULATION

- A. General: Air handling unit variable air volume (VAV) modulation shall be via solid state variable speed drives as specified in Section 26 2923 "Variable Speed Drives."

### 2.12 AIR HANDLING UNIT SPECIALTIES

- A. Ultra-Violet (UV) Germicidal Irradiation (UVGI) Systems

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### **[NOTE: SCHEDULE UVGI LIGHTS FOR RECIRCULATION/MIXED AHU'S ONLY. NOT FOR 100% OUTSIDE AIR AHUS]**

1. Where scheduled on the Drawings for recirculation/mixed AHUs only, provide factory installed UVGI lamps. Lamps shall provide a minimum irradiance of 9 Watts per square foot or 96.54 Joules per square meter at the cooling coil surface and at the coil leaving air temperature scheduled on the Drawings.
2. UV lamps shall be located:
  - a. Downstream of cooling coils
  - b. Above condensate drain pans
  - c. Upstream of final filtration sections on blow-through units only
3. UV Lamps and ballasts shall be UL listed for application in air handling systems.
4. UV lighting systems shall be moisture resistant with electronic ballasts and shall be wired using moisture resistant conduit.
5. UV lamps shall be capable of being switched ON and OFF at the respective AHU section access door.
6. UV lamps shall be interlocked with access door position limit switches such that they are de-energize when the doors open.
7. UV lamps shall be installed on a stainless steel grid using stainless steel fasteners in accordance with the manufacturer's installation instructions.
8. Air-handling units with view port windows from which the lamps can be seen shall be labeled to warn of possible eye damage.
9. Replacement lamps for UV systems shall be standard types that are not proprietary and are available from multiple sources.
10. All penetrations through AHU walls shall be thoroughly sealed to ensure no leakage. All UV susceptible materials in the AHU shall be shielded from line of sight UV. Installer shall remove all foreign matter such as dirt and metal shavings upon completion of installation.
11. UV lamp life shall be 9000 hours with no more than a 20% output loss at the end of one year of continuous use.

#### 2.13 ACOUSTIC PERFORMANCE

- A. General: The custom air handling units provided for the project shall be of a low noise design to reduce audible HVAC system noise levels in office areas and similar spaces adjacent to air handling unit rooms.

Edit acoustical requirements below to suit project. Coordinate requirements with acoustical consultant. Sound levels in adjacent spaces to mechanical rooms should not exceed those limits established in 2019 ASHRAE Handbook – HVAC Fundamentals, Chapter 49, Table 1. Coordinate with requirements in Section 23 0593 "Testing Adjusting and Balancing for HVAC".

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- B. Noise radiated from air handling unit shall not exceed the following sound pressure levels when measured 3 feet away from any exterior surface of unit. Sound pressure levels are indicated in decibels (reference 10-12 watts). Validate performance through factory and field testing. Refer to "Source Quality Control – Factory Tests" article.

1. Octave Bands (Hz)	Sound Pressure (dB)
63	65
125	58
250	53
500	49
1000	46
2000	46
4000	43
8000	37

### 2.14 SOURCE QUALITY CONTROL-FACTORY TESTS

- A. Factory-testing for vibration, acoustical performance and unit run testing shall be witnessed by the Owner's Representative. The Contractor shall pay for air fare, accommodations, and similar expenses so that two Owner's Representatives can witness the test.
- B. Submit test reports for each test indicating test equipment, procedures, results, dates, personnel performing tests and witnesses.
- C. **[Unit Run Test: Factory run test entire unit at design speed and simulated discharge static pressure and furnish report for casing integrity (panel deflection), leakage, acoustical acceptability, vibration, electrical system operation, module fit, workmanship and finish appearance prior to shipment from the factory. A complete vibration spectrum shall be conducted as specified. Any fan, motor, drive and base assembly vibration shall be brought to within specified levels prior to unit shipment. Fan tests conducted in the fan supplier's shop are not acceptable. Motor and drive vibration must be checked with the fan installed as a total assembly.]**
- D. **[Fan Vibration Test: Energize each fan after final assembly and perform a vibration analysis with fan operation at design speed and at all speeds throughout operating ranges from design to minimum. Three vibration readings shall be taken for each bearing in the horizontal, vertical and axial directions. These vibration signature shall be recorded and consist of vibration amplitude versus frequency. The maximum allowable fan vibration shall be [0.1] inch per second peak velocity with filter in.]**
- E. **[Acoustical Performance Test: Perform an acoustical performance test for each assembled air handling unit of unique size and performance. Air handling unit acoustic performance shall be verified by factory test in accordance with AHRI 260. Air handling unit supply-air discharge, return-air inlet, and casing radiated sound components shall be measured with air handling unit operating at design conditions. Perform testing in a location complying with AHRI 220, "Reverberation Room Qualification and Testing Procedures for Determining Sound Power of HVAC Equipment." Test location shall be broadband qualified in accordance with AHRI 220 Section 5.1 and discrete frequency qualified in accordance with Section 5.2. Operating**

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**conditions used in acoustic testing shall be verified by test in accordance with AMCA 210. Test results shall indicate that units comply with acoustical requirements indicated herein or on Drawings. Make changes to noncompliant air-handling units and retest until units comply with requirements.]**

### PART 3 - EXECUTION

#### 3.1 AIR HANDLING UNIT INSTALLATION

- A. General: Install air handling units in accordance with the manufacturer's written recommendations and as detailed on the Drawings.
- B. Housekeeping Pads: Install floor mounted air handling units on reinforced concrete housekeeping pads as specified in Section 23 0300 "Basic Materials and Methods."
- C. Vibration Isolators: Air handling units shall be installed with vibration isolators as specified under Section 23 0548 "Vibration Isolation" and separated from ductwork with flexible duct connections.
- D. Drain Connections: Pipe condensate **[directly to a primed floor drain without a trap for blow-through units and]** via a P-trap to a primed floor drain **[for draw-through units]**. Provide P-traps on air handling unit condensate drain connections with seal depths at least equal to the total static pressure of the unit as installed. P-traps shall be constructed of pipe and tees as detailed on the Drawings. Elbows shall not be used. All unused openings of tees shall be closed with removable plugs which shall serve as cleanouts.
- E. Coil Pull Space: Air handling units shall be installed with adequate space to allow unit coils to be removed **[without demolition of building construction]**. Coil pull space **[and any required demolition of building construction]** shall be clearly indicated on As-built Drawings. The Contractor shall insure that all field-piping, valves, ductwork, and other obstructions are not in the way or can be easily removed with flanges to facilitate coil removal.
- F. Vents and Drains: Provide **[manual] [automatic]** air vents and drain **[plugs] [valves with hose connections and caps]** for each coil section.

#### 3.2 AIR FILTERS:

- A. General: Unit shall be furnished and installed all filters as required for start-up.
- B. Filters and Accessories: Install filter racks, housings, and filters in accordance with the manufacturers' written installation instruction.
- C. Filter Sizes: In all cases, filters shall be of the proper size and installed in filter racks in such a manner that there will be no leakage of air around filters. Filters which have been torn, distorted, or damaged in any other way will not be acceptable.

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- D. Temporary Pre-filters: Provide blanket or roll filter media over the pleated pre-filters as temporary filter.
- E. Spare Filters: Furnish one complete stock of replacement filters and media, sufficient to replace all filters on each of the unit, to the Owner for maintenance use. Filters shall be delivered in their original, unopened containers, and stored as directed by the Owner.

3.3 TESTING AND BALANCING:

- A. General: Refer to Section 23 0593 "Testing, Adjusting and Balancing for HVAC" for air handling unit testing and balancing.
- B. Vibration Testing: Provide field vibration testing as specified.

3.4 IDENTIFICATION:

- A. Refer to Section 23 0300 "Basic Materials and Methods" for applicable painting, nameplates, and labeling requirements.

END OF SECTION 23 7420